RELATION OF ELEVATIONS TO THE BROOD

PERIODS, AND GENERATIONS OF D. BREVICOMIS.

Observations on the influence of elevation upon the broods of D. brevicomis were kept at the phenological stations on the Mistletoe route during the seasons of 1914, 1915 and 1916. During the winter of each season an infested tree was selected in which the broods, as nearly as possible, were uniform and consisted of full grown larvae ready to pupate. Sections of bark from this tree were placed on the north side of a tree at each phenological station ranging in elevations from 2700 to 5700 feet, and consecutive records kept throughout the season on the development of the broods in these transferred sections.

In these experiments it was found that as the elevation increased there was a pronounced retarding influence on the transformation from larvae to pupae and adults. While the larvae were apparently of the same age or stage of development during the winter, those which were kept at the lower stations pupated and emerged much earlier than those kept at the higher stations. This differences varied from 1 to 3 days for each 100 feet of elevation. This difference was consistent with that found in numerous other observations kept of plant and insect activities. The phenological observations kept at this series of stations show a marked retarding influence which modifies the phenological law for this locality. That the law is operative, however, is shown by the fact that both plants and insects consistently respond to these influences at the same elevation.

One marked feature shown by these records of development of D. brevicomis broods is that this retarding influence at the higher elevations holds back

the larvae much longer than it does the advanced stages of development. The larvae at the highest station may transform to pupae from 60 to 90 days later than those at the lowest station, but as soon as the pupae are formed they transform to adults and emerge almost as fast at one station as another. The forming of pupal stage apparently represents a critical point in the development of a brood , and it seems to represent the most sensitive index to the influence of temperature and climatic conditions upon the beetles.

During the season of 1917 the system of transferring bark to the different stations was abandoned and an effort was made to determine the difference in the actual brood periods between the lower and higher elevations. To do this the caging method, which was first tried out in 1915 was resorted to. One cage was established at the Station grounds at Ashland, Oregon, elevation 2000 feet and another cage near the summit of the Siskiyou at an elevation of 5000 feet and successive generations were carried through in logs kept in these cages. Conditions of the experiment and the results are described in the following notes:

D. brevicomis - Altitude, Generation Experiment - 1917.

This experiment consisted in carrying through the successive generations of D. brevicomis in logs confined in separate cages. One of these cages was located on the Station grounds at the Normal School Building, ele. 2000 feet. The other cage was located near Station 20 - Hardscrabble, Ore., at an elevation of 5000 feet.

Cage H.

Location - Station grounds, Ashland, Oregon, elevation 2000 feet.
Records kept by F. P. Keen, P. D. Sergent. Experiment was carried on in connection with painting and flight experiment #13317. A large quantity of bark containing D. brevicomis larvae and pupae was kept in adjoining cage G.
May 2, 1917 - Cage G. filled with infested bark
Cage H. two green logs placed for beetle attack.
May 7 - 300 D. brevicomis adults collected in cage G, liberated on log in Cage H.
June 9 - First larvae from attack on log in Cage H.
July 24 - new adults emerging - fresh log placed in cage on this date.
Aug. 8, 1917. Two new attacks on fresh log.
Aug. 11, 1917. 23 new adults counted on wall of cage. No attacks noted.
7 dead adults found in cage.
Aug. 22, new log examined - found adults extending galleries, depositing eggs.
Sept. 4 - 1/2 grown larvae.

Sept. 15 - 3/4 grown larvae.
Sept. 26 - full grown larvae and a few pupae.
Oct. 15, 1917. White fungus mold has apparently killed all stages in log. Experiment closed.

Cage I

Located at Phenological Station #20. Hardscrabble camp, Oregon. Cage built and records kept by P. H. Sergent.

May 9, 1917 - Cage built and 2 yellow pine logs placed inside.
May 16. Transferred 6 pieces of yellow pine bark (143 feet) to cage; bark contained full grown larvae and a few pupae.
June 5 - no emergence- noted many Hylurgops and carphoborus resting on outside walls of cage.
June 11. No emergence. Carphoborus attacking cage frame.
June 16 - 3 brevicomis adults on wall of cage.
June 25 - 8 adults on wall of cage. Yellow Pine log lying outside was attacked, adults just through outer bark. Records kept on both logs.

	Inside of Cage	Outside of Cage.
July 7	55 adults on wall - 2 attacks on log.	Parent adults eggs - small larvae.
July 16	14 " " " " 21 " " "	Egg - 1/4 grown larvae.
July 25	32 " " " " 35 " " "	Larvae 1/4 to 1/2 grown.
Aug. 1	No new attacks one side and end of cage town away by bear. Parent adults eggs, small larvae in log.	Larvae 1/2 to 3/4 grown.
Aug. 14	Larvae 3/4 grown	Larvae full grown
Aug. 27	Larvae nearly full grown	" " "
Sept. 7	Full grown larvae, few pupae.	A few pupae - sour sap has killed many larvae.
Sept. 24	Full grown larvae and pupae, a few new beetles.	Some pupae, some dead pupae.
Oct. 11	New adults emerging, 2 on walls of cage. New log placed in cage.	Beetles emerged.
Nov. 25	No attack on new log. Dead beetles in old log. May have been killed by scouring sap or fungi.	

These records are also shown graphically in the table on page 6 of this report.

It will be noted that the records for Cage I are fairly complete. Owing to the enlistment of Mr. Keen some of the records for the first seasonal generations in Cage H were lost, but we still have the records of first attack and emergence which gives the maximum period of this generation. The second seasonal generation in this cage died out before it reached the adult stage, apparently

due to the fungus mold which we were unable to control. However, pupae were recorded, and the time of emergence can be approximated by applying the average period from pupae to emergence as determined by Mr. Keen's intensive studies on the summer generation on the Lamb's Unit. According to this the beetles would have emerged about October 15.

The best comparison that we get from absolute records in this experiment is that between the periods of first attack and first pupae of the second seasonal generation in Cage H, with the first attack and first pupae of the generation in Cage I. This shows a difference of 25 days for the 5000 feet difference in elevation.

The seasonal generation in Cage I developed after the accumulated winter snow had disappeared. If this retarding influence is due to winter snow which presists on the ground until late in the spring and early summer, then the retardation upon insect development would be much less marked in the summer than in the spring months. While we do not have an absolute basis for comparison, I think that this is borne out by comparing the spring records of transferred bark with the summer records of this experiment.

One important economic feature to determine, however, is the number of annual generations which may develop at either the lower or the higher elevations, in this locality. This experiment shows that at an elevation of 2000 feet the season will permit the development of two complete annual generations and a partial third. This same result was attained by experiment in 1915. At 5000 feet, however, the season will permit only the development of one complete annual generation. This is shown by the chart on page 7.

These experiments, however, represent the maximum number of generations, as very little if any time can be allowed for the period of flight between emergence and attack in the cages. Mr. Keen's studies on the Lamb's Unit 1916

show that under natural conditions in the field the generations quantitatively will not hold up to this maximum. This is due to retarded emergence of individuals and a period of flight averaging 26 days. Taking an average of the yellow pine belt at 5500 feet it is probable that the number of generations is one complete annual generation and a partial second, the average being slightly less than two complete generations. For all practical purposes the life history data of Bulletin 85 will answer for this locality.

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Ashland, Oregon.
Jan. 26, 1918.

Assistant Forest Entomologist.

D. brevicomis - Altitude, Generation Experiment, 1917.

Cage H, Station Grounds, Ashland, Oregon, Elevation 2000 feet.

	May		June	July 1		August			September			October.
Date	10	7	9	24	8	11	22	4	15	26	15	
Year Date	130	127	160	205	220	223	234	247	258	269	288	
Brood		6										
records	1				1							
	2		3		2	2	2	3	3	3		
				6						4		

First Seasonal Generation-75 days

Second seasonal generation 49 days (estimated 67 days)

CAGE I, HARDSCRABBLE CAMP, SISKIYOU MOUNTAINS, ELEVATION 5000 feet.

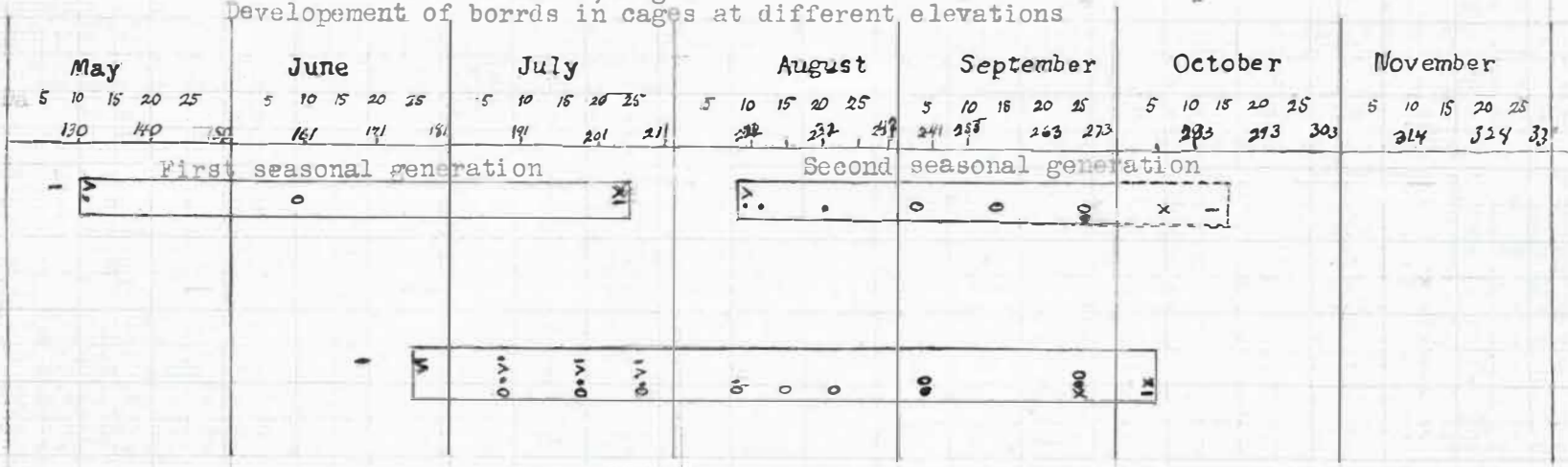
Date	16	25	7	16	25	1	14	27	7	24	11
Year date	167	176	188	197	206	213	226	239	250	267	284
Brood	6	6	6	6	6						
Records		1	1	1	1						
			2	2	2	2					
			3	3	3	3	3	3	3	3	
									4	4	
										5	5
											6

One seasonal generation - 108 days

Legend.

1. Attack by parent adults
2. Eggs.
3. Larvae
4. Pupae
5. New adults
6. Emergence of new adults.

DENDROCTONUS BREVICOMIS - GENERATION EXPERIMENT
Ashland, Oregon-1917
Developement of borrds in cages at different elevations



LEGEND

> attack
• eggs
o larvae
• pupae
× new adults
– emergence of new adults

Legend.

> 1. Attack
• 2. Eggs
o 3. larvae
• 4. pupae
× 5. new adults
– 6. Emergence